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INTERCHANGEABLE KEYBOARD  
WITH SELF DEFINING KEYS

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I N T E R N A T I O N A L   B U S I N E S S   M A C H I N E S  
C O R P O R A T I O N

POU920010030US1

# **INTERCHANGEABLE KEYBOARD WITH SELF DEFINING KEYS**

## **Related Application**

U.S. Patent Application Serial No. (POU920000031US1), filed on even date herewith and entitled "Reformable Keyboard with Variable Key Design".

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## **Field of the Invention**

The present invention relates to the field of computer keyboards and more particularly, to the layout of computer keyboards for use by the disabled.

## **Background of the Invention**

The disabled are presented with a number of challenges which other users take for granted  
10 when it comes to using computer systems. Most people take it for granted that we can walk up  
to any personal computer and start typing. However, there are a variety of disabilities which  
make it difficult or impossible for some people to use a standard keyboard layout. For example, a  
person with a handicap affecting one hand may do better if the most commonly used keys were all  
aligned within the range of the other hand. Meanwhile, the cognitively disabled may find that an  
15 alphabetically arranged keyboard serves them best. In any case there is not one keyboard layout  
that would accommodate all handicaps. Computer keyboard layouts have to be tailored to the  
disabilities of the particular individual.

Most computer keyboards are made up of keys, each with a cap and an underlying key  
post, and a detection mechanism that registers that a key has been pressed. Once pressed, the key  
20 sends a key code to the computer system indicating which key was pressed, and software  
interprets the key stroke. There are many keyboards where the keys snap in and out of place.  
Such keyboards could be remapped for the disabled by moving keys and then redefining the  
keyboard's layout to the computer's operating system. While this mix of activities may not be a

major hurdle for those skilled in computer systems, it is beyond the abilities of most of the disabled or those who assist the disabled in adjusting to their environment. This leaves a disabled individual unable to use computer systems or require him/her to search for an expert to specifically reconfigure a computer system to their needs. Once reconfigured, that computer system then becomes a problem for others to use. Further the disabled individual is unable to apply skills required with the use of the modified computer system to other computer systems.

Therefore it is an object of the present invention to provide a keyboard which can be easily reconfigured to accommodate the handicaps of a specific user.

It is another object of the present invention to provide a modified keyboard that can be used with any computer system without requiring special programming or modification of the computer system.

### **Brief Description of the Invention**

In accordance with the present invention, each keyboard key is marked with a self-defining indicator. A matrix of key sensing circuits for the keyboard are configured to detect this indicator when the keys are depressed and provide an output to a keyboard controller which in turn provides key signals to the computer interface connector of the keyboard which signals are indistinguishable by a computer system from the output of a standard keyboard. This enables the disabled user to carry the keyboard of the present invention from one computer system to another and simply exchange it for the standard keyboard for the computer. There are not changes required to be made to the operating system or any software of the computer in order to allow the disabled user to use the computer. Furthermore, other users are not required to do anything special to start using the computer system once the standard keyboard is re-installed.

### **Brief Description of the Drawings**

The present invention and its object features and advantages can be best understood by reading the following description of embodiments thereof while referring to the attached figures of which:

Figure 1 is a plan view of a standard QWERTY keyboard layout;

5 Figure 2 is a side view of a key incorporating the present invention;

Figure 3 is a bottom view of the key of Figure 2;

Figure 4 is a top view of the key of Figures 2 and 3;

Figure 5 is a schematic of a switch matrix and controller for use in a keyboard having the keys of Figures 2 to 4;

10 Figure 6 is a block diagram of the controller of Figure 5;

Figure 7 is an alternative design for keys in accordance with the present invention; and

Figure 8 is a position in a matrix designed to accommodate keys in accordance with the design of Figure 7.

### **Description of the Preferred Embodiment**

15 Figure 1 shows a keyboard with a standard QWERTY layout. Included in the keyboard 100 are a plurality of well-known alphanumeric control key members 102 having indicia 104 representing the character to be printed. The keyboard further includes a plurality of operating keys 106 and row of customer programmable keys 108. the keyboard includes two shift keys 110 and 112 for use in notifying the processing unit to shift the data of a depressed control key 102  
20 from the lower case to the upper case.

For many disabled users the standard QWERTY layout of Figure 1 is difficult or impossible to use and a different positional arrangement of keys on the keyboard would be more suitable. For instance, certain of the disabled may have very limited use of say the left hand and need a keyboard with the more commonly used keys grouped on the right side, or people with  
5 limited cognitive ability may require keys to be arranged in alphabetical order. The keys in most keyboards are removable and can be changed from position to position on the keyboard. However in order for a computer to properly interpret keystrokes, the computer must be reprogrammed to recognize the modified keyboard configuration.

In accordance with the present invention, the keys are each imprinted with information  
10 that identifies their function making their position on the keyboard transparent to the computer to eliminate the necessity for reprogramming the computer. As shown in Figures 2 to 4, a lettered keycap 200 is fixedly mounted on a key post 202. The key post 202 extends through an opening 204 in the top surface 206 of the keyboard and contains a ridge 208 that is positioned in a guide slot 209 to assure the key is properly oriented in the keyboard. Two diagonally positioned  
15 flexible legs 210 and 212 slide in paths 214 and 216 to act as guides for the vertical movement of the key while permitting easy removal and insertion of the keys. Feet 218 and 220 at the end of the legs hold the key in position against upward spring action 221 between the cap and the top surface of the keyboard. The keys are plastic with the keycap, legs, and post molded in one piece.

20 The bottom of the key post contains eight cylindrical cavities 222. Metallic studs or pins 224 are inserted into certain of the cavities in accordance with the USA Standard Code for Information Interchange (ASCII), to uniquely identify each of the keys by a combination of the number studs assigned to the key and their positions in the cavities of the key. While the ASCII code is preferred, other codes are possible. With 0 to 8 pins positioned or not positioned in  
25 various combinations in the cavities, there are 256 different possible combinations ranging from the case where all cavities are empty to that where all cavities are full. The condition where all the cavities are empty is not used as a key code, leaving 255 different pin-cavity combinations to

uniquely identify each of 256 different letters, number and function keys. The keyboard of Figure 1 has 85 keys. Therefore there are sufficient combinations to identify each of the keys in that keyboard and for extended keyboard layouts.

- 5 Referring now to Figure 5, a switch matrix unit 500 is utilized in the keyboard 100 for outputting a signal representing the depression of any key in the keyboard 100 of Figure 1. This matrix unit includes a plurality of input row conductors  $R_1$ - $R_n$  inclusive and a plurality of output column conductors  $C_1$ - $C_n$  inclusive. The row and column conductors have at each of their intercepts a capacitive device 502 associated with a different key member of the keyboard of
- 10 Figure 1. A controller 504 in the keyboard 100 detects a multi-bit binary signal called a make code when a key is depressed and a break code when the key is released. Both the make and break code signals are detected to eliminate any false or missed key signal which may occur when the make codes for more than two keys overlap.

- To produce the make and break code signals, each column conductor  $C_1$  to  $C_n$  is
- 15 successively scanned by a strobe pulse in a manner that is well known in the art. The strobe pulse is generated by the controller and provided to the matrix on connection 506. If any key on a column has been depressed at the time of the generation of a scanning strobe pulse, for that column, at least one row conductor for the key will be energized by the strobe pulse to produce a make code pulse, which pulse will be transmitted over the energized row conductor to the
- 20 keyboard controller 504 which generates the proper multi-bit scan code representing the depressed key at the keyboard interface 508 with a computer 510 through a standard keyboard connector which, with certain exceptions, will plug into any computer and enable the keyboard providing the proper scan codes to operate with that computer.

- In the matrix of Figure 5, eight switches are associated with each key position on the
- 25 keyboard. For instance, the capacitive devices in positions  $R_1 - C_2$  to  $R_8 - C_2$  are associated with one key position. While the capacitive devices in positions  $R_1 - C_2$  to  $R_8 - C_2$  are shown arranged in a single line, they are actually clustered under the key post position with each capacitive device positioned under one of the cavities in the bottom of the key post so that it can be activated by a

metal pin positioned in that cavity. In this way, the number of pins associated with a key and their position in the key, generate a binary signal which is a combination of eight "0s" and "1s" when the key is depressed, a different combination of "0s" and "1s" for each key in the keyboard.

While the described keyboard uses capacitive switches in which the studs change the state of the capacitive switches to indicate to the controller that a key being depressed, other arrangements are possible. They can include use of a mechanical keyboard where studs make physical contact to close a connection or a keyboard in which key switches are contained in membrane layers.

As shown in Figure 6, the controller 504 includes: a microprocessor 604; a volatile working memory 606; a read only memory (ROM) 608 containing the microprocessors operating system and application software; and an input/output interface 610 and a buffer 612 used in interfacing the computer 510 and the matrix 500 through the bus 614 to the other elements of the controller. The keyboard controller 504 also includes a look up table in a non-volatile memory 602 in which the parallel eight bit key make codes for each of the keyboard keys are stored along with the corresponding serial multi-bit scan codes to be provided to the CPU 510. The controller 504 recognizes a break code received from the switch matrix as one stored in the lookup table in non volatile memory and transmits the corresponding scan code to the keyboard-PC interface 508. The scan code is transmitted to the computer 510 through the keyboard buffer for instance to a second keyboard controller located in the computer where they are recognized as the appropriate characters or control codes.

An alternate form of keyboard keys in accordance with the present invention is shown in Figure 7. In Figure 7, the key post 702 in each key contains a logic circuit 704 electrically connected to two studs 706 and 708. The circuit 704 contains a key identifier that uniquely identifies each key in accordance with the previously described ASCII code scheme. As shown in Figure 8 each key is located over one intersection of a row  $R_j$  and  $C_j$  in a matrix of such columns and rows. When a key is depressed switches 802 and 804 are closed completing a circuit through the circuit energizing the circuit 704 from voltage on the column conductor  $C_j$ . Then the ASCII code signals of the key identifier are serially transmitted along the row line  $R_j$  to the controller 504 which is adapted to received a serial input of the identifier.

Above we have described two embodiments of the present invention. Of course those skilled in the art may provide modifications of the described embodiments for instance the interface terminal on the keyboard could be USB connector and the on board keyboard controller could be programmed to communicate with the computer through the USB interface. Therefore  
5 it is understood that the invention is not limited to the described embodiments but encompasses the spirit and scope of the appended claims.

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